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Original Article

Effects of horse-riding exercise on balance, gait, and activities of daily living in stroke patients

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Abstract. [Purpose] This study aimed to investigate the effects of horse-riding exercise on balance, gait, and activities of daily living (ADLs) in stroke patients. [Subjects] Among 20 participants with stroke, 10 were randomly assigned to the experimental group, and 10 were randomly assigned to the control group. The experimental group participated in horse-riding exercise for 30 minutes per day, 5 days a week for 6 weeks. Balance was tested with the Berg Balance Scale (BBS). Gait was measured using the 10-Meter Walk Test (10MWT). ADLs were tested with the Modified Barthel Index (MBI). Differences between pre- and post-experiment values within the two groups were compared using paired t-tests. Between-group differences were compared using independent t-tests. [Results] The experimental group showed significant improvements in balance, gait, and ADLs following horse-riding exercise. Additionally, the experimental group showed significant differences in balance, gait, and ADLs compared with in the control group. [Conclusion] These results support that horse-riding exercise enhances balance, gait, and ADLs in stroke patients. This study supports the need for further research on horse-riding exercise programs.
Key words: Horse-riding exercise, Balance, Activities of daily living

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INTRODUCTION

Stroke, caused by ischemia or hemorrhage, results from the interruption of blood supply to the brain that induces constant deficiency of oxygen and causes brain damage[1)]. Though fatality after stroke has been greatly reduced by the development of medical technology, stroke presents physical and mental obstacles that impair quality of life[1, 2)]. Once a stroke has occurred, various motor skills deteriorate, and therefore stroke rehabilitation focuses greatly on exercises designed to recover motor skills[2)].

Balance is the ability to sustain the center of gravity, and it is a complex process of controlling posture when conducting a voluntary movement and responding to external perturbations[3)]. Stroke patients often experience hemiplegia, weakness of one side of the body that induces unbalanced posture, loss of proprioception, and abnormal muscle tone, thereby reducing balance ability[4, 5)]. Due to balance instability, stroke patients develop an abnormal gait with a short weight support duration on the affected side, and differences between the strides of the normal side and affected side cause the gait speed to decrease, affecting physical ability and impairing independent daily activities[5, 6)].

In order to solve problems concerning balance, walking, and daily activities related to stroke, various treatment methods such as neurological development treatment (NDT), proprioceptive neuromuscular facilitation (PNF), the Brunnström approach, and motor relearning programs have been developed[7)]. Ideal treatment programs are yet to be discovered, and various approaches are being developed for more effective treatment[7, 8)].

Many approaches to physical therapy are being developed, and horse-riding exercise is one method being tested for rehabilitation. Horse-riding exercise is a complex and scientific therapeutic method resembling movements from riding a horse[9)]. Horse riding strongly stimulates proprioceptive sensation by providing the rhythmical and repetitive movements of a horse. These movements stimulate the upper motor neuron system and input information similar to movement patterns of the pelvis when walking[10, 11)]. Such movements control abnormal muscle tone and movement patterns while enhancing balance and walking[11)]. Positive effects that can be induced from horse-riding exercise include recovery of disability in patients with cerebral palsy, multiple sclerosis, and spinal cord damage[10, 12, 13)].

Recently, research related to horse-riding exercise is being conducted, but studies investigating the effect of horse-riding exercise on balance, gait, and activities of daily living (ADLs) in stroke patients are still lacking. Therefore, the purpose of this study was to investigate the effect of simulated horse-riding exercise on balance, gait, and ADLs in stroke patients.

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SUBJECTS AND METHODS

This study included 20 patients diagnosed with stroke on MRI at least 6 months prior to the study. Participants were randomly assigned to a control group (5 males, 5 females) and an experimental group (5 males, 5 females), who participated in a horse-riding exercise program. The inclusion criteria were a Mini-Mental State Examination (MMSE) score greater than 24 points, ability to walk more than 10 meters independently, and Brunnström approach stage of four or greater. Participants were excluded if they suffered from a visual disability or orthopedic disease of the lower extremities. Before the experiment, all participants were notified of the purpose and method of this study and provided written consent in advance. This protocol was approved by the Institutional Review Board of Nambu University and was conducted in accordance with the ethical standards of the Declaration of Helsinki. The general characteristics of the participants are listed in Table 1. The mean age of the experimental group was 71.1 ± 3.0 years, mean height was 170.5 ± 7.3 cm, mean weight was 71.2 ± 7.4 kg, and mean time from stroke onset was 10.6 ± 1.1 months. The mean age of the control group was 69.2 ± 3.4 years, mean height was 167.9 ± 6.5 cm, mean weight was 67.0 ± 6.5 kg, and mean time from stroke onset was 10.8 ± 1.1 months.

Both groups were treated using an NDT approach for 30 minutes per day, 5 days a week for 6 weeks. Horse-riding exercise utilized mechanical equipment that effectively resembles the movement of an actual horse (JOBA EU7800, Panasonic Corporation, Osaka, Japan). The equipment generates three-dimensional movements including twisting, up-down slide, back-forth slide, up-down roll, and back-forth roll. In this study, a whole body course and partial body course were alternately conducted, and the difficulty was increased from level 1 to 4, according to the adaptability of the participants. Participants were allowed to freely control their posture and were instructed to grab the handle to ensure correct posture while riding.

Balance was measured using the Berg Balance Scale (BBS). The BBS is composed of a total 14 items and covers sitting, standing, and posture changes. The total score is 56 points, and a higher score corresponds to better balancing skill. Gait was measured using the 10-Meter Walk Test (10MWT). The 10MWT measures time spent while walking a total of 14 meters, excluding the first and last 2 meters. ADLs were measured using the Modified Barthel Index (MBI). The MBI has a total score of 100 points and contains a total of 10 items including personal sanitation, independent bathing, eating, using the bathroom, dressing, controlling bowel movements, controlling urination, walking or using a wheel chair, and moving towards a bed or chair. Scores of 0 to 24 indicate total dependency, scores of 25 to 49 indicate mostly dependent, 50 to 74 indicate moderate dependency, score of 75 to 90 indicate minor dependency, and score of 91 to 99 indicate minimal dependency. All measurements were carried out before and 6 weeks after the experiment.

Data were analyzed using SPSS 12.0 (SPSS, Chicago, IL, USA). General features of the participants were detailed as means and standard deviations using descriptive statistics. Differences before and after the experiment within the two groups were compared using paired t-test analysis. To compare between-group differences before and after the horse-exercise therapy experiment, independent t-tests were used. The level of statistical significance was set as $\alpha = 0.05$.

Table 1. General characteristics of the participants

	Experimental group (n=10)	Control group (n=10)
Gender (male/female)	5/5	5/5
Age (years)	71.1 ± 3.0[a]	69.2 ± 3.4
Height (cm)	170.5 ± 7.3	167.9 ± 6.5
Weight (kg)	71.2 ± 7.4	67.0 ± 6.5
Paretic side (right/left)	5/5	5/5
Onset (months)	10.6 ± 1.1	10.8 ± 1.1

[a]Mean±SD

Table 2. Comparison of BBS, 10MWT, and MBI measures between the experimental and control groups

	Group	Pre	Post
BBS (Bug Balance Scale)	Experimental group	42.4 ± 1.3[a]	44.1 ± 1.2[*#]
	Control group	41.6 ± 1.3	42.2 ± 1.6
10MWT (10-Meter Walk Test)	Experimental group	19.9 ± 0.8	18.5 ± 1.0[*#]
	Control group	20.0 ± 0.9	19.7 ± 0.6
MBI (Modified Barthel Index)	Experimental group	88.0 ± 1.4	91.5 ± 2.1[*#]
	Control group	87.3 ± 2.0	88.2 ± 1.8

[a]Mean±SD
*$p<0.05$: paired t-test
[#]$p<0.05$: independent t-test

RESULTS

The changes in the scores of the in BBS, 10MWT, and MBI are listed in Table 2. The experimental group exhibited significant differences for all pre- and post-experiment variables ($p < 0.05$). The control group demonstrated no significant different for all pre- and post-experiment variables ($p > 0.05$). In the between-group comparison, the outcomes of the experimental group were significantly difference from those of the control group ($p < 0.05$).

DISCUSSION

The purpose of this study was to investigate the effects of horse-riding exercise on balance, gait, and ADLs in stroke patients. Significant improvements in balance were as observed in the experimental group ($p < 0.05$) but not in the control group. Balance, gait, and ADLs were significantly different between the two groups ($p < 0.05$). Research by Han et al.[14] and Lee et al.[15] found the BBS to be more significantly improved among those participating in horse-riding therapy than in control subjects. Horse-riding exercise simulates the natural walking rhythm of a horse, which is similar to that of the human trunk during motion. While a constant movement pattern is being applied, the trunk muscles act to counteract gravity[14–16]. Reduction of the instability of trunk muscles

and enhancement of proprioception and vestibular function are considered to improve balance ability[16, 17]. Such results mean that the horse-riding exercise used in this study has positive effects on balance in stroke patients.

Patients with hemiplegia from stroke exert a great deal of energy and have difficulty walking independently[18]. Changes in gait were observed to be significant in the experimental group but not in the control group ($p < 0.05$). In the between-group comparison, the outcomes of the experimental group were significantly different from those of the control group ($p < 0.05$). Lee et al.[15] showed significant gait speed improvement following horse-riding exercise. McGibbon et al.[19] used horse-riding exercise in children with cerebral palsy for 12 weeks, and it enhanced gait skill by activating adductor muscles. This study also applied a similar exercise program and showed similar results. Rhythmical and repetitive movements of the mechanical horse simulate movements during gait and provide a positive effect on gait skill[20]. Constant pelvis movement and enhancement of trunks motor skills seem to improve the walking ability of patients.

Stroke patients need to set goals to improve balance and gait skills that can enable independent daily activities[21]. Significant changes in ADLs were observed in the experimental group ($p < 0.05$) but not in the control group. In the between-group comparison, the outcomes of the experimental group were significantly different from those of the control group ($p < 0.05$). Jung et al.[22] showed improvement in movements related to daily activities in children with cerebral palsy following a horse-riding exercise program. Kim[23] used horse-riding exercises in autistic children, and their movements of daily activities significantly improved, coinciding with this study's results. Horse-riding exercise uses various movements in a horse that can naturally provide physical effects to stimulate and activate shortened muscles in order to improve movements in daily activities.

One limitation of this study is the small number of participants, which precludes generalization. Follow-up studies will need to confirm the durability of these effects, and further research should verify the benefits of horse-riding exercise.

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